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ABSTRACT

Throughout America's secondary science classrooms, students struggle to master fundamental science principles, especially when math-related applications are involved. For example, in chemistry students struggle to solve quantitative problems. This paper presents an activity that leads to a useful understanding of dimensional analysis; i.e., unit conversions, and an example of linking new information to past experiences in order to promote learning of an otherwise difficult and remote concept. (ASK)

Linking New Learning with Previous Experiences: An Activity in Teaching Dimensional Analysis

by
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Throughout America's secondary science classrooms, students struggle to master fundamental science principles, especially when math-related applications are involved. Certainly some struggle is necessary for learning and growth, but too often students are discouraged by previous academic difficulties and by the lonely prospects of continuing on into an academic field that seems to be isolated from all other life experiences. This discouragement can quickly dash interests and reduce career prospects before students know enough about an academic field to make an educated judgement. This reduction in prospects is most limiting to students facing the prospects of life in an information-processing society where adults commonly change career tracks several times before retirement.

Researchers since Piaget have explored the relationship of previous learning and experiences to new learning endeavors. The notion is emerging that though students come to class with a wide range of previous learning and experiences, optimal learning occurs

only when information is made meaningful (Moore, p.55). The theoretical notion, called constructivism, suggests that effective learning occurs when students create such meaning by linking new information to what they already know, thus generating new combinations very personal meaning and perspective (Good and Brophy, 1997).

Teachers who are willing to get to know their students can do much to foster and nurture these linkages of old and new knowledge. Gardner (1993) refers to such linkages as the "logic of implications" and suggests that they be promoted by critical thinking about chosen topics across differing subject areas. One way teachers can do this is by using cooperative activities, role playing and simulations that make classroom teaching more student-centered (Freiberg and Driscoll, 2000). Such activities bring an academic diversity and social exchange to a subject, increasing its proximity to real-life student experience.

Over years of teaching chemistry, we noticed that our students struggled to solve quantitative problems. Our attempts to teach the valuable analytical tool of dimensional analysis (using units to set up and solve problems) met with meager results. Dimensional analysis

was perceived by students to be a vague and difficult chemistry construct that they could only dimly understand, let alone use to advantage and with confidence. Therefore, we determined to identify a real-life experience to which students could relate, and from that to develop an activity that would help them learn to use master this very useful strategy.

Through discussions we learned that many of our students had traveled and most were familiar with one or more foreign currencies. Further, we learned that many more of our students expect to travel in the future and have heard stories about American overseas being perceived as wealthy and conspicuous targets of unscrupulous merchants. We then developed the following classroom activity upon this foundation. We recommend it as an activity that has led to a useful understanding of dimensional analysis and as an example of linking new information to past experience in order to promote learning of an otherwise difficult and remote concept.

Dimensional Analysis
(a.k.a. Unit Conversions)

Directions: Carefully read the following story. Use the attached page to help you create a relationships chart. Use your relationships chart to solve the problems asked in the story. Show all work how the units cancel to give your answer) in the space provided. Use the Help page included as an example.

Welcome to Malawi!!

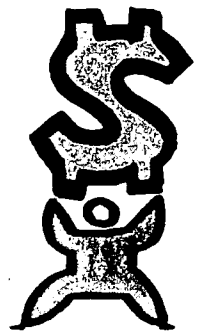
It is the year 2001, and you have graduated from Your high school. However, like many of your peers, you are not really sure what you want to do with your life. You have thought about college, the military, a trade school. You just can't decide. However you do know you would like to do something worthwhile, and perhaps help needy people. After thinking and talking to counselors, you determine to join the Peace Corp for a few months while you decide on a future direction.

You are excited to learn that your first assignment will take you to the small country of Malawi in southeastern Africa, near Mozambique. You vaguely recall hearing the name Malawi while lazily watching an episode of "Where in the World is Carmen San Diego?" last summer. You get the necessary paperwork finished, get the appropriate battery of shots, say good-bye to family, and hop on a plane to Africa.

Once in Africa, you board a bus for the small town of Zomba located in Malawi. Upon arrival, you ask where you can find food. The airplane food wasn't the greatest and the bus didn't have food for you. Your Peace Corp supervisor hands you a brochure, and handful of what appear to be pebbles and beads, and points you toward the town's market. Brushing through the brochure you realize that buying food here is going to be a bit difficult. Apparently these people use an old system of money that does not operate in increments of ten. Attached is a copy of the flyer your supervisor gave you to explain the money system.

Welcome to Malawi

Our Currency System



We use ivory coins and brass coins. These include:

- an uban of ivory, an ubic of ivory, an uber of ivory, and a lumbar of ivory
- an artock of brass, a ballock of brass, an olum of brass, and a tarman of brass.

Equivalencies to remember:

- An artock of brass is equal to an uban of ivory, and either of these can buy a jal of most fruits.

- The amount of an ubic of ivory is twice the value of an uban
- An uber of ivory is twice the value of an ubic
- A lumbar of ivory is equal to the value of three uber

- A ballock of brass is as great as two artocks
- An olum of brass is as great as four artocks
- A tarman is equal to the value of three olum.

There are also smaller coins than those listed above. These are the values of the lesser coins:

- A san is half an artock of brass; therefore, a san could usually buy half a jal of most fruits
- A soon is half a san
- A leah is half a soon
- A gulag of ivory is equal to three san of brass.

American equivalencies:

- A jal is a basket whose volume is about the same as a half of a gallon.
- The current exhange rate is 1.00 for 2 uban

Name_____

Questions

You notice a stand with some nice bananas, but you don't think you're up to eating a whole jal of bananas. You ask the proprietor the price of 3 bananas, which look like about 1 quart. He quotes you a price of 2 gulag. You know that in the U.S. you can typically buy a quart, or 3, bananas for about 50 cents. **Show all your work!**

1. According to the proprietor, what is the price of the African bananas in artocks per quart?

2. According to the proprietor, what is the price of the African bananas in dollars per gallon?

3. According to the Malawi flyer, what is the typical price of a jal of bananas in artocks per jal?

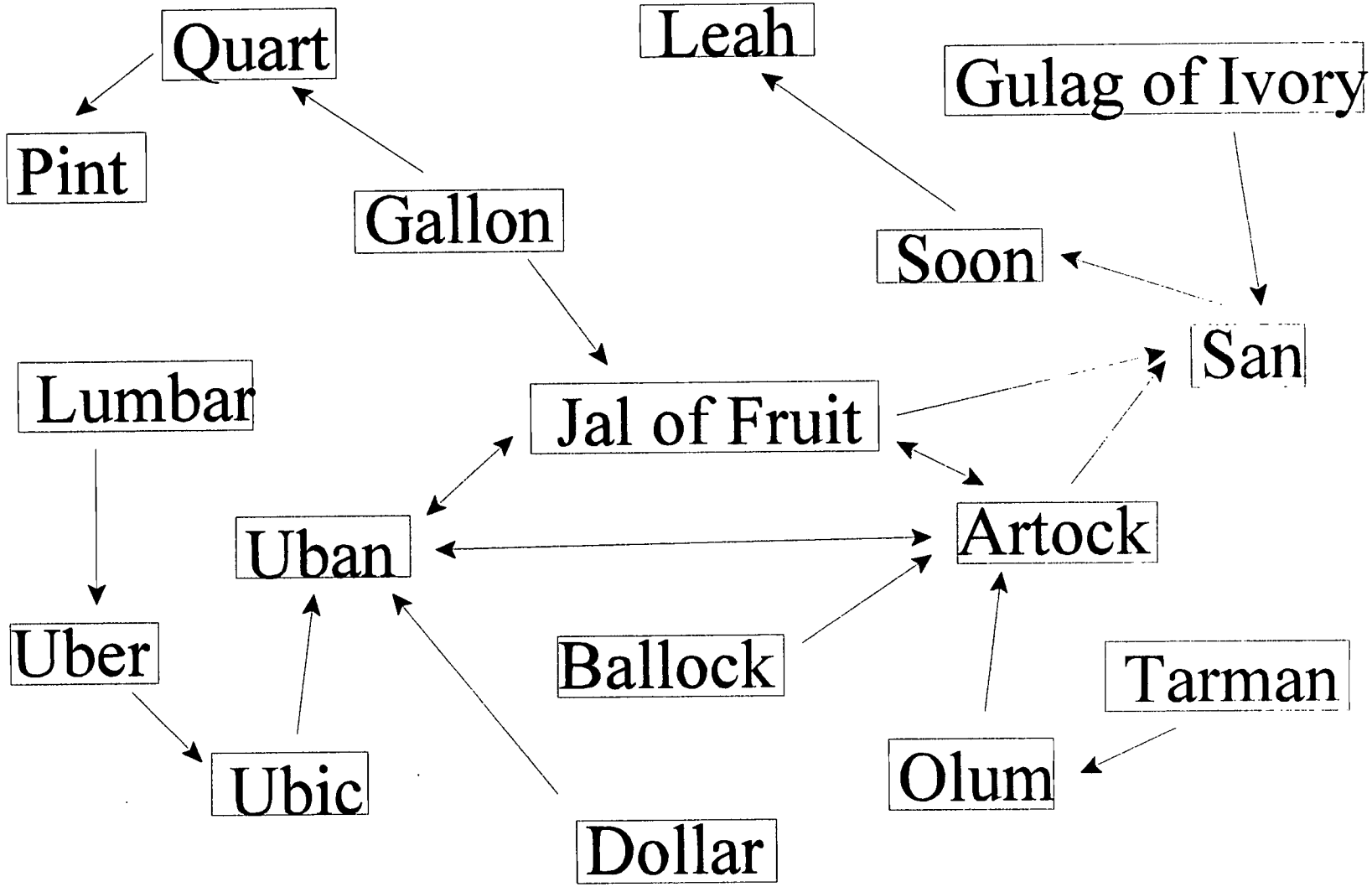
4. Convert your answer from question 3 to artocks per quart.

5. Did the proprietor try to cheat you? (Compare your answer from question 4 to your answer in 1.)

6. Compared to American bananas, is the typical price (the flyer price) of African bananas in Malawi expensive or cheap?

7. How many uber of ivory are equal to 4 tarman of brass?

8. What is the relationship between an artock and a tarman?


Quart
Leah
Gulag of Ivory
Pint
Gallon
Soon
San
Lumbar
Jal of Fruit
Uban
Artock
Uber
Ballock
Tarman
Ubic
Olum
Dollar

Help: Making Sense of this Money System

Using a simple but deliberate procedure, you can take the mystery out of this exotic money system and be confidant that you are dealing (and being dealt with) fairly.

A. Using the data given in the brochure, write the unit relationships upon the arrows connecting those units on the map provided (example: write 2 san/1 artock on the arrow connecting san and artock).

B. Use the map to help set up and solve currency questions. First determine what you want to find and what you are given. Then write down the steps (relationships) that take you on the shortest route from what's given to what's wanted, arranging units to cancel and leave you with your answer.

Example

How many jal are equivalent to 5 Gulag?

Solution

$$\text{? Jal} = 5 \text{ Gulag} \times \frac{3 \text{ San}}{1 \text{ Gulag}} \times \frac{1 \text{ Jal}}{2 \text{ San}}$$

? Jal = 7.5 Jal

Key

1. ? artocks / quart. = 2 gulag / 1 quart; 3 sans / 1 gulag; 1 artock / 2 san = 3 artocks/quart

2. ? $ / gallon = 3 artocks / 1 quart; 1 uban / 1 artock; 1 $ / 2 uban; 4 quarts / 1 gallon = $6/gallon

3. 1 artock/jal

4. ? artocks / quart = 1 artock / 1 jal; 2 jal / 1 gallon; 1 gallon / 4 quarts = .5 artocks/quart

5. Yes! The proprietor charged 3 artocks/qt. The official brochure says that bananas should cost only .5 artocks/quart.

6. U.S. Bananas
   $ .5/quart

   Malawi Bananas
   ? $ / quart = .5 artock / 1 quart; 1 uban / 2 artock; 1 $ / 2 uban = $ .25/quart

   Therefore, Malawi Bananas are cheaper than U.S. Bananas

7. ? uber = 4 tarman; 3 olum / 1 tarman; 4 artock / 1 olum; 1 uban / 1 artock; 1 ubic / 2 uban; 1 uber / 2 ubic
   = 12 uber

8. ? tarman = 1 artock; 1 olum / 4 artock; 1 tarman / 3 olum
   = 1/12 tarman

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